CHAPTER 9

STEEL MOMENT RESISTING FRAMES

9-1. Introduction. This chapter prescribes the criteria for the design of steel moment resisting frames in seismic areas.

9-2. General.

a. Functions. Steel moment resisting frames have functions and behavior similar to those of concrete moment frames. Refer to the general discussion of moment frames in chapter 8.

b. Frame types. There are two types of steel moment frame: the special moment resisting frame (steel SMRF) and the ordinary moment resisting frame (steel OMRF). Refer to SEAOC 4F6 for the use of trusses in moment resisting frames.

9-3. Steel special moment resisting frames (steel SMRF).

a. General design criteria. The criteria used to design steel special moment resisting frames will be the latest edition of the AISC *Specification* as modified by SEAOC 4A through 4D, 4F, and 4J. SEAOC 4A provides the basic reference to the eighth edition of the AISC *Specification;* SEAOC 4B provides the definitions applicable to steel construction; SEAOC 4C provides the requirements for steel materials and defines member strength used in the provisions that require development of member strength; SEAOC 4D provides for the strength of columns, the details of column splices, and the evaluation of slenderness effects; and SEAOC 4F provides the detailed requirements for steel SMRFs.

b. Limitations by seismic zone. As provided in SEAOC 4A2, structures in Zone 1 need not conform to the requirements of SEAOC Chapter 4. SEAOC 4F provides that structures in Zone 2 need conform only to Paragraphs 1, 6, 7, and 9 of the detailed requirements of SEAOC 4F.

c. Basic requirements. The basic requirements for steel SMRFs relate to the relationship between beams and columns and the connections between beams and columns.

(1) *Strength ratio.* SEAOC 4F5 provides for a strength ratio between columns and beams intended to ensure that plastic hinges will form in the beams rather than the columns. Exceptions to this requirement are allowed when compactness limitations are satisfied and load demands are relatively low. The SEAOC commentary includes a discussion of the strong column/weak beam concept.

(2) *Girder-to-column connection.* There are two fundamental requirements:

(a) SEAOC 4A1 provides a requirement for the strength of the girder-column connections. In order to meet this requirement, the girders will be connected to columns by rigid joints that are capable of developing the lesser value of the flexural strength of the girder framing into the joint, or the moment correponding to the development of panel zone shear strength as defined in SEAOC 4F2. For typical details refer to figure 9-1.

(b) SEAOC paragraph 4F2 deals with the shear strength required in the joints of frames. In order to meet these requirements, the thickness of the column web in the panel zone may have to be increased, either by choosing a column with a thicker web or by adding doubler plates. The panel zone and doubler plate dimensional requirements are summarized in figure 9-2.

d. Details. Several paragraphs in SEAOC 4F relate to details of the frames.

(1) *Flange width-thickness ratio.* SEAOC 4F3 refers to AISC 1.5.1.4.1 regarding allowable stresses in bending and modifies the limiting girder flange width-thickness ratio to $65/\sqrt{F_y}$.

(2) *Continuity plates.* SEAOC 4F4 refers to AISC formula 1.15-3 when determining the need for tension flange continuity plates and adds a requirement for the quantity P_{bf}.

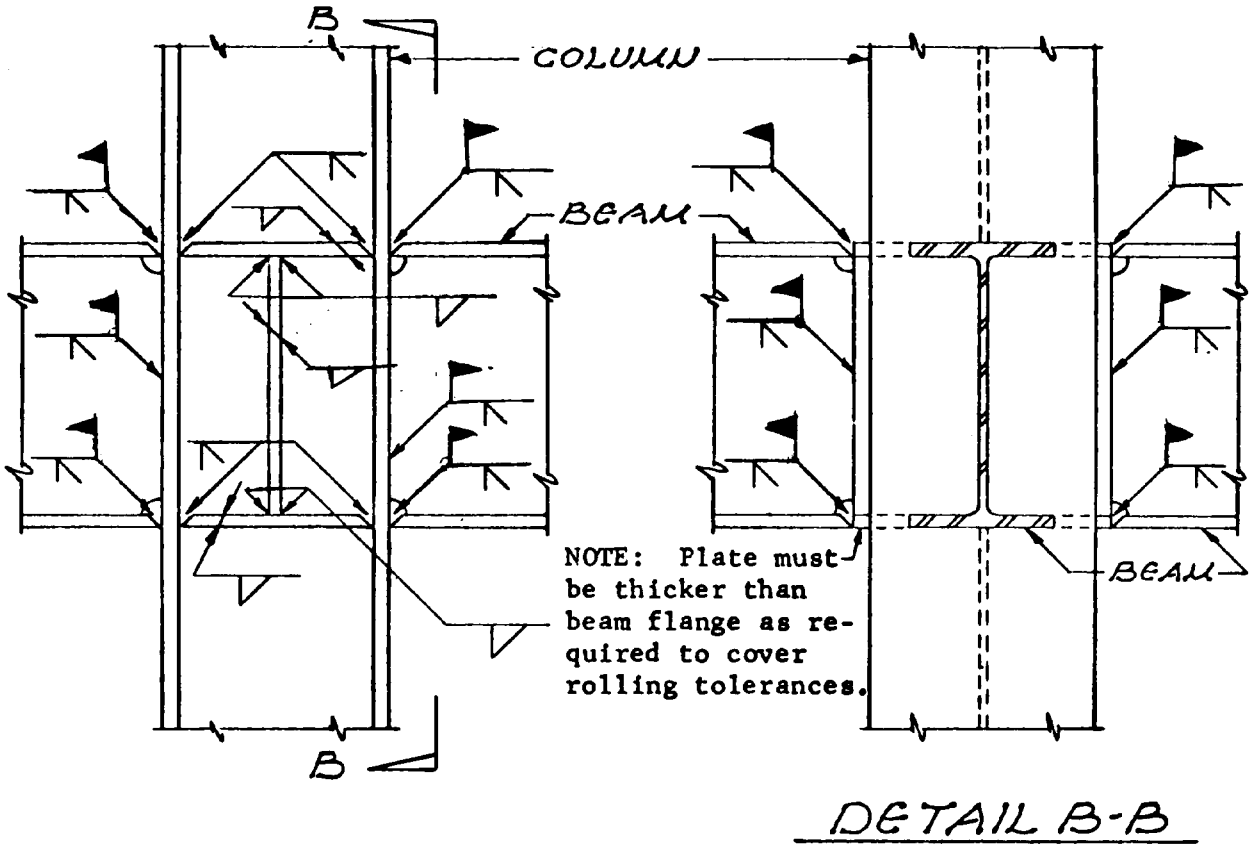
(3) *Changes in beam flange area.* SEAOC 4F9 prohibits abrupt changes in girder flange area within possible plastic hinge regions.

e. Stability of frames. SEAOC 4F7 provides requirements for the stability of girder-column joints, with provisions for restrained (laterally supported) joints and unrestrained (laterally unsupported) joints; SEAOC 4F8 provides requirements for bracing of girders between joints.

f. Drift of frames. SEAOC 4F10 provides requirements for the calculation of frame drift.

g. Trusses in frames. The special moment frame provisions, originally developed for frames consisting of wide-flange beams, have been extended to include frames whose beams are trusses. The requirements for these frames are given in SEAOC 4F6.

h. Inspection. As with other structural systems, the system R_w-values for steel SMRFs are assigned with associated requirements that the detail requirements be met and that appropriate inspection be provided. Refer to SEAOC 4J for the requirement for nondestructive testing of joints in steel SMRFs.



NOTES:
WELDS UNLESS SHOWN AS FILLET WELDS ARE FULL PENETRATION BUTT WELDS. USE BACKING STRIPS OR CHIP AND USE BACKING WELDS.
THE PURPOSE OF THIS BEAM AND GIRDER CONNECTION TO THE COLUMN IS TO DEVELOP THE FULL PLASTIC CAPACITY OF BEAM AND GIRDER.
OTHER CONNECTION DETAILS WHICH ARE CAPABLE OF DEVELOPING THE PLASTIC CAPACITY OF THE CONNECTED BEAMS AND GIRDERS MAY BE USED.

Figure 9-1. Steel SMRF.

9-4. Steel ordinary moment resisting frames (steel OMRF).

a. General design criteria. The criteria used in the design of steel moment resisting frames will be the latest edition of the AISC Specifications, modified by SEAOC 4E.

b. Limitations as seismic moment resisting frames.

(1) Frames without special seismic details or loading. In Zone 1, ordinary moment frames may be designed with $R_w = 6$.

(2) Frames without special seismic details but with special loading. OMRFs without special details may be used if they are capable of resisting the combination of gravity loads and $3(R_w/8)$ times the design seismic force. In Zone 1, an R_w value of 12 may be used; in Zones 2, 3, and 4, R_w 6. In Zones 3 and 4, there is a height limit of 160 feet.

(3) Frames with girder-to-column connections that meet the requirements of SEAOC 4F1. R_w = 6, and in Zones 3 and 4 there is a height limit of 160 feet.

c. Girder-to-column connections. Each beam or girder moment connection to a column will meet the requirements of SEAOC 4F1 for SMRFs unless it can be shown that it is capable of resisting the combination of gravity loads and $3R_w/8$ times the design seismic forces.

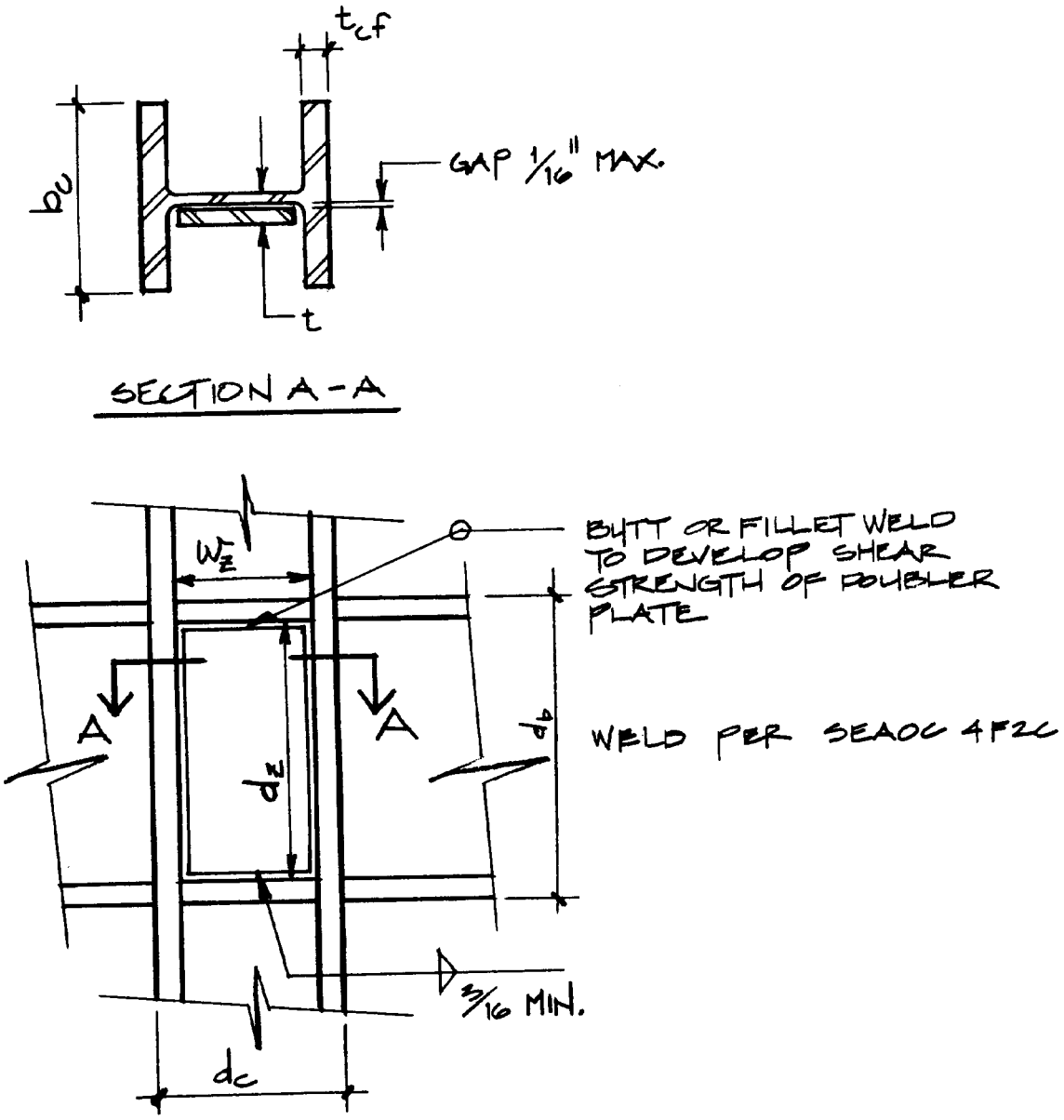


Figure 9-2. Panel zone details.